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ABSTRACT

The purpose of the study was to describe two outlier schools, portraying their commonalities and differences and utilizing the metaphors of chaos theory in understanding the descriptions and patterns of the two schools. Rather than focusing on individual parts of a school, the study looks at each school as a dynamic system in which individual efforts affect all and where single variations create unpredictable outputs. The findings revealed some recurring patterns in the schools. In both schools, everyone articulated the same school mission, the belief that all children can learn, and that the school was responsible for ensuring that learning takes place. The vision of the schools, their consistency and predictability, was strong enough to influence the behavior of the people both inside the school and within the community. This shared vision showed up at every level because those behaviors were patterned into the school's organizing principles. (RJM)

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Chaos Theory Metaphors:

A Lens for Viewing the Quality School

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Chaos Theory Metaphors:

A Lens for Viewing the Quality School

As educators, we encounter numerous discussions of quality. Perhaps our thoughts enhance understanding when we look at schools considered to be quality schools and seek to determine the organizational process that propels their journey. In many cases, there are quality schools that should not be experiencing their levels of success. Viewed as a whole, these schools succeed in spite of the odds. These are outlier schools: that is, schools possessing many of the at-risk characteristics identified in the literature but are more successful than they are supposed to be (Brookover & Lezotte, 1977; Edmonds & Frederickson, 1978; Firestone, 1991; Weber, 1971).

The outlier is an anomaly thrown out as statistical analysis, but it is considered meaningful in the qualitative perspective (Bobner, Newman & Wessinger, 1989). While the scientific method of research treats outliers as totally random events, other researchers (Bobner, et al., 1989; Crowell, 1989; Doll, 1989; Griffiths, Hart & Blair, 1991; Lindsay, 1991) contend that this previously thought randomness exhibits reappearing patterns. The presence of these patterns suggests that the data are not truly random; definite boundaries are present (Bobner et al., 1989). According to Bobner et al. (1989), chaos theory defines this phenomenon as "nonrandom behavior that cannot be accurately predicted on a long-term basis" (p. 3).

Although chaos theory has been applied in numerous disciplines (Crutchfield,

Farmer, Packard & Shaw, 1986; Shaffer & Kot, 1985; Skarda & Freeman, 1987), its use is relatively new to educational research. Schools have been studied through numerous lenses. Researchers have identified components of effective schools (Edmonds, 1977a, 1977b), but the use of the metaphors of chaos theory is a relatively new way to explore what happens within the context of a quality school. Chaos theory is a philosophical and empirical approach to explain relationships that were thought to be totally random. The behavior of chaotic systems appears to be random, but repeatable patterns are discernable; therefore, the discernable patterns can be used to describe the behavior of the system, but not to predict it (Bobner et al., 1989). Chaos theory maintains that relationships have constrained randomness and that universal patterns exist in complex systems. These patterns were previously viewed as experiential noise or the outlier.

Method

The purpose of the study was to describe two outlier schools, portraying their commonalities, differences and utilizing the metaphors of chaos theory in understanding the descriptions and patterns of the two schools. While there are numerous metaphors associated with chaos theory, Hayles (1990) identified five characteristics that chaotic systems typically share: (a) nonlinearity, (b) complex forms, (c) recursive symmetries, (d) sensitivity to initial conditions, and (e) feedback mechanisms.

Nonlinearity is a metaphor that describes the incongruity between cause and effect so that a small cause can give rise to a large effect. In education,

nonlinearity suggests that all events deserve attention and monitoring. If administrators fail to think holistically, relationships that may result in major effects may not be seen or may be simply ignored because they are small initially.

Complex forms is another characteristic of chaotic systems (Hayles, 1990). Whereas classical science dictated that objects are independent of the scale measuring them, chaotic systems dictate that as the scale of measuring decreases, the shape being measured changes qualitatively and quantitatively. In education, the two level nature of systems is seen as seemingly random individual events. When measured and modeled, these events show embedded patterns. For example, when observed from a distance, a school appears to be one system, yet, when it is viewed closely, the same school displays numerous embedded patterns.

Recursive symmetries between scale levels is the third characteristic outlined by Hayles (1990). This quality suggests a shift in focus from the individual unit to a focus on scale levels. The individual unit does not matter; what matters are recursive symmetries or self-similarities between different levels of the system. In education, symmetry is constructed within the system by its rules and goals (Blair, 1993). These rules and goals of a system tie the organization together as they are repeated at each level.

Sensitivity to initial conditions is another characteristic of chaotic systems identified by Hayles (1990). She used the example of a bowling ball moving down the alley, touching only a small surface of the alley; its curvature makes it extremely sensitive to small motion tremors. In education, time after time,

administrators express bewilderment when their best efforts go awry. Just when things seem to be going well, pandemonium breaks out often in response to seemingly insignificant instigators (Blair, 1993).

Feedback mechanisms, the fifth characteristic of chaos theory suggested by Hayles (1990), specifies that complex systems create loops in which output feeds back into a system as input. Gleick (1987) used the example of a microphone picking up a noise loud enough for the amplified sound from the speakers to feed back into the microphone in an endless, ever louder loop. With the nonlinear system, small fluctuations are not smoothed out but can be magnified through bifurcations or a dividing process. Bifurcation occurs when something small is amplified by iteration to a size so great that a fork is created, and the system moves in a new direction. In education, an example of feedback is information from the system's output (i.e., test scores) being fed back into the system as input, and the system reinforces itself (Blair, 1993). These metaphors are explanations for complex processes associated with chaos theory.

Qualitative research methods such as those described in Guba and Lincoln (1985) were used in this study. The case study was the primary data method employed. The schools were selected by purposeful sampling based on expert testimony. Observing, interviewing, and reviewing documents were the methods of data collecting.

This study provided a new way of looking at educational systems. Rather than focusing on individual parts of a school, the study focused on the school as a

dynamic system in which individual efforts affected all and where single variations created unpredictable outputs (Lindsay, 1989).

Procedure

Two good elementary schools were selected using Lightfoot's selection technique based on reputation (1983). An attempt was made to uncover what makes these two elementary schools serving at-risk students quality schools. The researcher spent five days in one of the schools; in the other, shorter visits were numerous. The investigation began with general questions from which emerged an array of interests. Teachers were interviewed, their teaching observed, and their concerns noted. Students were also interviewed. Principals shared their goals, and their leadership was observed in the schools. Observations were recorded; interviews were taped and documents were collected. Each school was treated separately.

Lomax-Pinevale Elementary School

One of the four elementary schools within the district, this school serves the largest percentage of poor children in the system. The school draws its student population from the city's two largest federal housing projects and the surrounding areas. More than 25% of the students live in the housing projects. Poverty is evident throughout the entire community. Almost 50% of the parents inside these homes have no high school education. Less than 25% of the fathers are employed; 32% of the mothers are employed. Approximately 90% of the students qualify for free lunches. More than 75% of the students live in single-parent homes.

According to school records for incoming kindergarten students, over half of these students enter kindergarten without preschool skills. The student body currently is 97% black, 2% white, and less than 1% other. From a distance, one would not expect to find a good school in the midst of all the poverty, yet the school's reputation portrays this school as "the light of the community."

The annual program for developing community leaders recognizes this light and selected the school as a model for education with all the leader trainees visiting the site. The Rotary Club with its 175 members acknowledges the light and continues an on-going weekly partnership with the school. Also, the local university acknowledges its light and uses the school as a training ground for education majors. The children's performance substantiates the light. In 1992, 63% of the students within the school qualified for Chapter I services. Using the same eligibility criteria three years later, only 42% are now eligible, and students are meeting state established goals on standardized assessments.

The programs, the practices, and the personnel work together to enable this school to be a good school. Fused together, all of these components enable the school to attain its goals: increased student achievement, positive self-esteem, and parent involvement. The attainment of each goal becomes another ray imparted by the light.

Metter Elementary School

Originally built to house the county's black students and subsequently used as the county's middle school, this facility, built in the 1950s, now houses Metter

Elementary School. One expert described the school as "an oasis within a desert." The desert includes the entire county which has over 25% of its habitants living below the poverty level. Almost 25% of the county's population have less than a ninth grade education, and approximately 50% have not completed high school. In 1991, 44% of the total live births in the county were to unwed mothers; and 42% of the total households within the county were headed by a female. The county is dotted with small farms. Fifty-two % of the families live on these farms. Approximately 65% of the population is white; 32% is black and 3% are Hispanic. At Metter Elementary, 36% of the students live in nontraditional family settings and 60% qualify for free or reduced meals.

One school expert suggested that the oasis offers hope for the children within the community, that this is a school concerned with "the total welfare of every child." He further describes it as a "welcoming place; a place that brings back the good feeling I had about school when I was a child."

As he talked further of his feelings about the school, he related that he finds the teachers in the school to have a "high level of commitment," with "a lot of energy," and with "smarts." Also he related that the principal is the "guiding force" behind the efforts of the school that has taken "a combination of the best curriculum practices, reworked them, made them their own. They searched for what will work for their children."

Metter Elementary is an innovative school and one of the state's first multi-age schools. Promoting Achievement in Child-Centered Education (PACE) is the

major program within the school. This program, described as the center of all the other programs within the school, is a program of continuous progress that ensures academic success and maximum opportunities for the development of self-esteem and socialization of children in multi-age groups. Teachers stress portfolio assessment and thematic units. The teachers employ teaching strategies that address the physical, intellectual, social and emotional development levels of children. Among these strategies are an abundance of learning centers. Heterogeneous grouping is a practice at the school as is the inclusion model. Other practices include: children remaining with a teacher for two years, thereby enabling teachers to become their school mothers; the staff participating in shared decision-making; and parents being encouraged to be a partner with the school throughout the school year.

Metter Elementary, sitting in the middle of a "desert," could not be expected to foster innovations. When the curriculum director for the system was asked to outline how this oasis in the desert could exist, she quickly detailed:

> Look at the expectations of the principal and look at the attitude of the teachers toward the principal. The teachers believe they can succeed, and the principal pumps them up and shares with them her belief that they can all be successful.....It's the leadership...no program can work without the right people.

This good school, serving a high percentage of at-risk children, is a composite of people, programs, and practices that the staff believes enables them to provide their children a good education. This oasis stands ready to meet the developmental needs of the children who enter.

Findings:

A number of recurring patterns were identified. The chaos metaphors (i.e., nonlinearity, complex forms, recursive symmetry, sensitivity to initial conditions, and feedback mechanism) were used to understand the recurring patterns. Although each school was treated separately, commonalities and differences between them surfaced and other patterns inside each school emerged within the recurring patterns. The patterns within these recurring patterns indicated that one school was not a replica of the other. Furthermore, each principal acknowledged that she would not want the other school to be her school. The study of the two quality schools through observations, interviews, and a review of documentation verified differences between the two (Bridges, 1994). Differences, however, were often found by slight degrees, and commonalities were frequently manifested in different ways.

The major difference found within the patterns was in the programs that each faculty had selected. Although different programs had been utilized by each school, the programs found in both schools focused on child-centered learning activities. While developmentally appropriate practices were incorporated in the activities within both schools, a greater emphasis on discovery learning was found in Metter Elementary while Lomax-Pinevale provided a more structured learning environment. There were opportunities in both schools for experiential learning, but Metter children were provided more opportunities to learn through discovery and field trips. On the other hand, the outside world came to Lomax-Pinevale.

There were varying degrees of autonomy within the two schools, or the schools involvement of the central office was slightly different. One school was was a member of the League of Professional Schools with a shared governance program thoroughly in place, while the other had to conform somewhat to what was done in the other three elementary schools within the system.

There was a slight variance in the communication and feedback system. One principal received ideas and gave her suggestions before they were tried; she was the authority, the researcher. Teachers expected her to be their instructional leader, to lead the way. The other principal was sometimes informed after the fact. Teachers in her school engaged in experimentation first and then shared the results. Then together they would decide the effectiveness of the work. Both principals knew intimately the totality of the school.

The areas of qualitative patterns in which commonalities persisted throughout the programs, practices and personnel indicated, however, that the schools were more similar than different. Recurring commonalities included what the schools believed (i.e., mission, beliefs, goals, commitment and shared vision). Other commonalities included what the school did (i.e., searching, sharing, changing, revising, caring, protecting, building self-esteem, nurturing, teacher importance, power and responsibility, environment, family, parent involvement, welcoming environment, community involvement, communication and companionship). Furthermore, the principals were very similar in personality, commitment, energy, communication skills and total involvement in the school.

An attempt was made to determine if the five chaos theory metaphors suggested by Hayles (1990) helped to explain why each school, although possessing similar as well as dissimilar components, was a good school.

Nonlinearity means that a very small change has an impact far beyond what could have been predicted. In nonlinearity, the study related that wholeness cannot be studied in pieces. Rather, the whole of the school depended upon the minutest part with the part becoming the whole; as any one part was changed, so was the whole. In both Metter and Lomax Pinevale, the parts were in a constant state of change; therefore, it was necessary to study each overall school rather than to study an accumulation of selected parts to describe what was happening to each. Nonlinearity, as observed in these schools, also indicated that schools must pay attention to minor events because they can quickly become major ones.

Complex forms connotes that numerous patterns are embedded within the system and pattern within pattern within pattern. Complex forms explained that schools are too complex and too irregular for one to know everything about them; schools cannot be separated into bits and pieces. When viewed from a distance, each school in the study appeared to be one identity. Yet, secondary analysis revealed that many more patterns were found embedded within patterns. Decision-making displayed these patterns. Rather than decisions coming from the central office or at any one level of the organization, the study showed the same pattern repeated throughout the organizations. At Metter, the principal made decisions; so did the teachers, and so did the students; hence, patterns within patterns. At

Lomax-Pinevale, the principal made more decisions than did the teachers and the teachers made more decisions than did the students; again, pattern within pattern. The study affirmed the impossibility to know every detail and the importance of gaining enough understanding to allow the shape of the school to emerge from the myriad of variables that influence it. It is important to look for themes and patterns rather than for isolated causes.

The chaos theory metaphor of recursive symmetry or self-similarity dictates that each level of the system displayed the same qualities. A pattern reappears itself, scaling, on an ever-decreasing scale. In these schools, an observer could tell what personnel in each school valued by watching anyone in the school. There was consistency and predictability to the quality of behaviors. No matter where one looked within each organization, self-similarity was found in the people, in spite of their roles or responsibilities.

In each school, everyone articulated the same school mission. The mission provided the organizing principle to allow similar behaviors to appear at every level within the school. *The belief that all children can learn* compelled everyone and everything in the school to be aligned with that belief. *The belief that the school was responsible for ensuring that learning takes place* mandated that all programs and practices reflect that belief. The vision for each school was strong enough to influence the behavior of the people both inside the school and within the community.

This metaphor provided an understanding that a school's guiding principles, mission, philosophy, or vision is strong enough to influence and shape the behavior of every employee into a desired member of the organization. When the vision is shared, it is repeated throughout the school. These principles show up at every level because those behaviors were patterned into the organizing principles at the start. This understanding dictates the necessity of each school's development of a guiding framework. The mission pervades the entire organization.

Sensitivity to initial conditions suggests that very small differences at the beginning of the system's evolution make prediction impossible. It further details that minor disruptions in any part can create major changes in the system as a whole. The slightest variation can have explosive results. This metaphor explained why a single model of a good school is impossible. Because each school is different initially and because one can never know all the variables in the beginning, one school cannot move in the exact direction as another. No single model can be constructed. This understanding provided an explanation as to why these schools, both good schools, were different. Each school was different initially; then iteration or information feeding back on itself and changing in the process created powerful and unpredictable effects in these nonlinear systems, making it impossible for one model to capture the systems (Bridges, 1995). The systems of each school fed back on the school, enfolded all that had happened, magnified slight variances, encoded in the systems memory, and prohibited prediction, thus making each school different.

The fifth metaphor utilized in describing and in understanding the two schools is feedback mechanism which specifies that complex systems create loops in which output feeds back into the system as input. The metaphor implies that a system changes in a way that remains consistent with itself in that environment. As it feeds back into itself, the future form it takes will be consistent with the identity it has previously established. Thus, change does not happen randomly but is consistent with what has gone on before. Information feeding back into the system increases and disturbances grow which require the system to change. Disturbances create disequilibrium that leads to growth; from disorder comes order. This metaphor explained how the numerous innovative programs and practices (i.e. multi-age grouping at Metter and the parallel block scheduling at Lomax) could be utilized in these schools as each faculty searched for ways to attain its mission. All of the innovations within the programs and practices were bound back to the mission and to what had gone before. The feedback or input back into the system facilitated change and yet brought order within each school. In addition, feedback or self-referencing provided a basis for explaining how a high degree of autonomy could exist in these schools. Autonomy is not to be feared as each part of the system and each person within has to remain consistent with itself and with all other parts of the system as it changes. Similarly, the metaphor provided understanding as to why creative individuals in each school had an enormous impact on the school as a whole. As these individual's disturbance feeds back into the system, the system uses the disturbance to recreate itself.

The chaos theory metaphors provide a different lens for viewing two good schools. Nonlinearity offered insight into why each school, although somewhat similar, was also different from the other. Complex Forms gave credence to the study of each school as a whole. It suggested that one can never know all the irregularities of a school, instead one can understand the patterns. Recursive Symmetries stressed that the whole is greater than its parts. When the whole is bound to a mission, all the parts contribute to the whole.

Sensitivity to Initial Conditions indicated that a school model is impossible; every one is different because exact initial conditions can never be known. Yet, with all the variations in school, the strange attractor prevents the school from flying out into chaos. These concepts suggested that the mission of the school is what gives meaning to life; when the mission is shared, each person contributes to that mission. Feedback Mechanism proposed that although schools may experience change, this change feeds back into the system and allows the system to recreate itself. Furthermore, this metaphor dictated that principals should acknowledge each person's role in creating the school. Change promotes autonomy as each person's input makes a difference in the school as a whole.

The examination of two quality schools through the metaphors of chaos theory provided helpful insight into the process of viewing good schools. The observers viewed qualitative patterns finding commonalities and differences between the two schools. Finally, chaos theory has promise as a different lens for viewing, describing, and understanding schools.

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